eRD101 - mRICH

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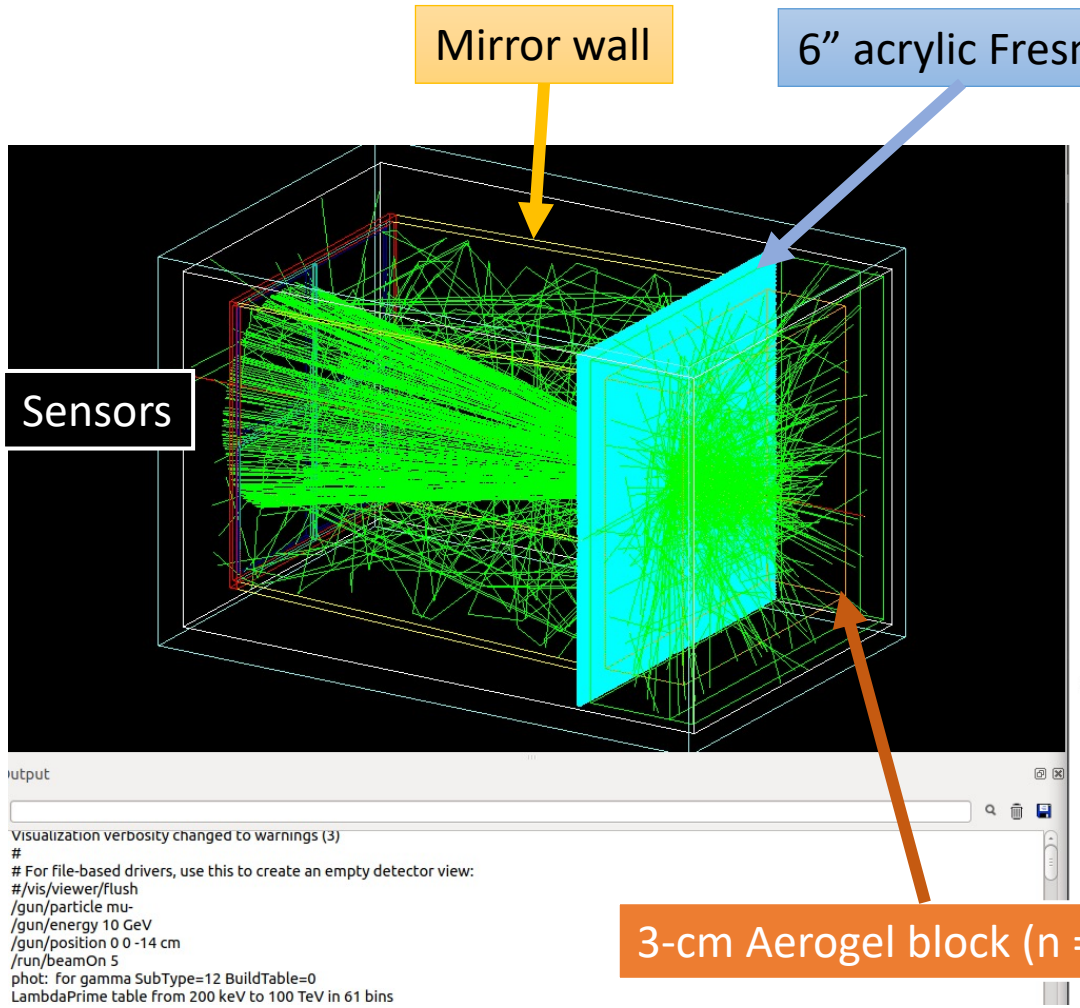
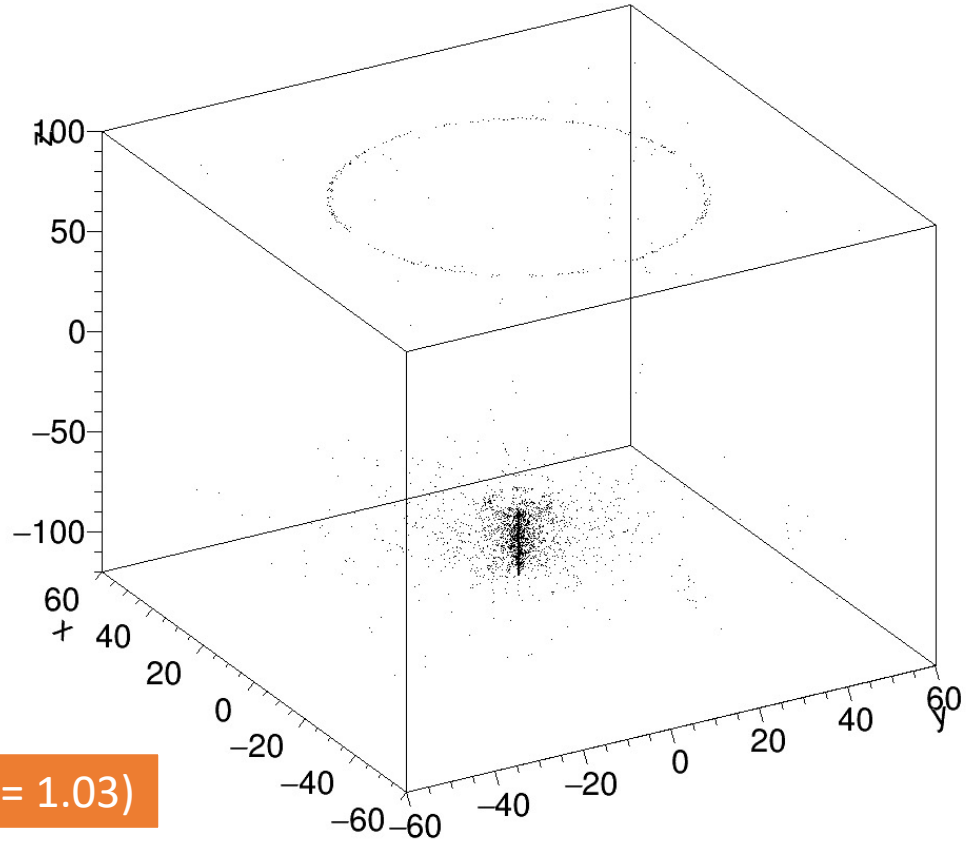
mRICH – past, present and future plan

- The initial “mRICH” concept was proposed by Hubert van Hecke at LANL around 2014. Starting in 2015, GSU group took the lead and started working on mRICH prototyping and GEANT4 simulation as part of eRD14 (generic EIC Detector R&D program). We are grateful to the generic R&D committee led by Thomas for the strong support and guidance that made mRICH the most tested and is well developed detector for EIC.
- The first mRICH beam test (using 3” Fresnel lens + 6mm x 6mm pixel size) was done in 2016 which was followed with an improved optical component design (6” Fresnel lens + 3mm x 3mm pixelated sensor). We are currently conducting the 3rd mRICH test with tracking at JLab (see next slide). In June of 2021, we also participated a LAPPD characterization beam test at Fermilab with hope to see its potential application for mRICH.
- As you all know well, mRICH is in the EIC baseline detector concept in the Yellow Report, which has been implemented in GEANT4 simulation both for ATHENA and ECCE based on the 2nd mRICH prototype design. A few critical analyses raise an important question – will mRICH work as a PID detector in electron endcap because of present material budget, gaps between modules, and the associated readout. Our short answer is YES but we also need to continue our R&D and show to the community it is the best choice.
- So, the future is the present. We have taken the feedback from the community seriously and have started addressing every one of them. As a matter of a fact, we (with Gary Varner at Hawaii Univ) worked with an engineer student (in Switzerland, as a research project) in summer of 2020 and explored the new design options for mRICH. Mitigating the risk factors is the focus of coming mRICH R&D effort.
- Very recently, thanks go to Beni Zihlmann, a new engineer (Alex Eslinger) at JLab started looking into the support structure design for mRICH. Also, Igor Shein (+ designer) from IHEP (Protvino) and Alexander Barnyakov from Novosibirsk (BIND) and Moscow (INR) expressed interest to work on the mRICH needs.

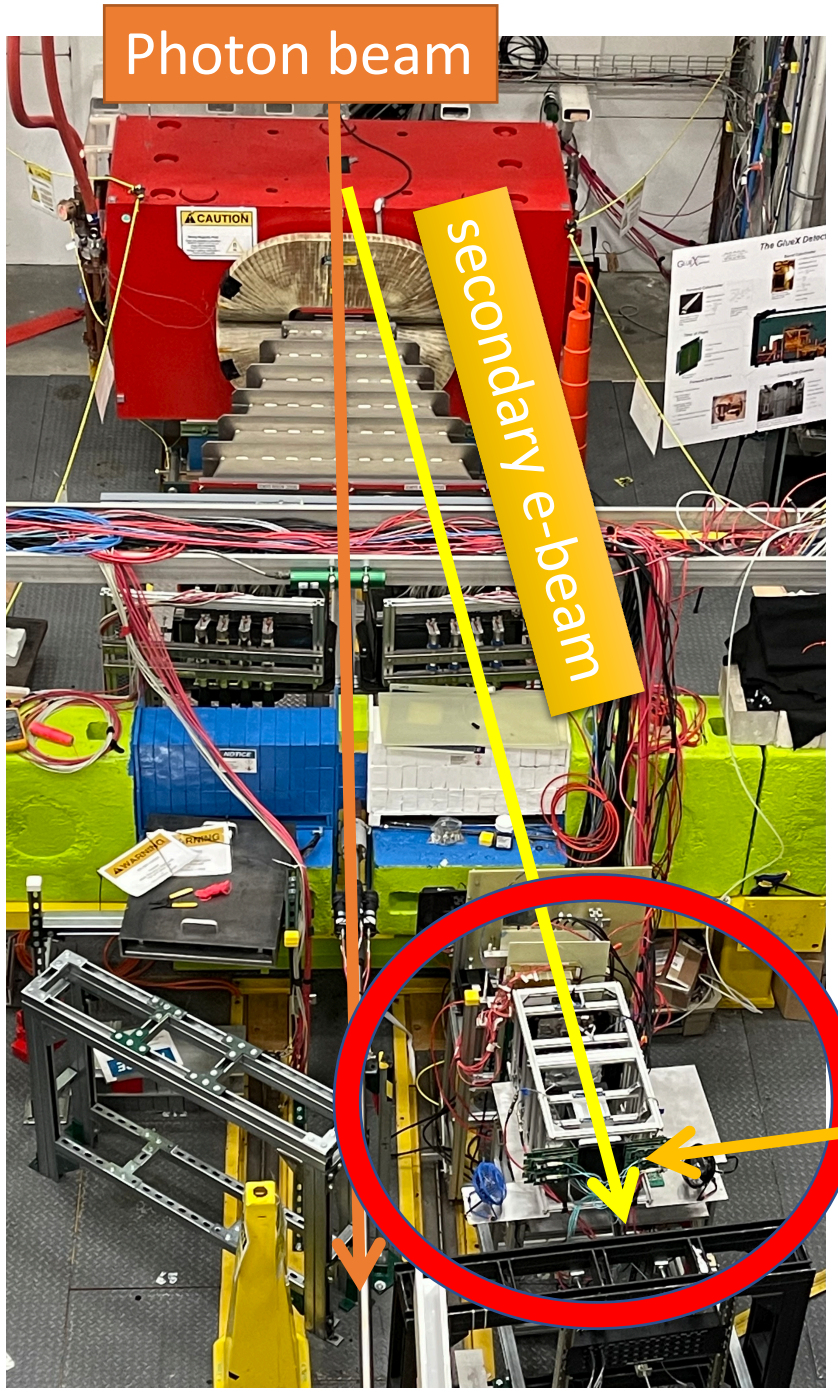
mRICH Features

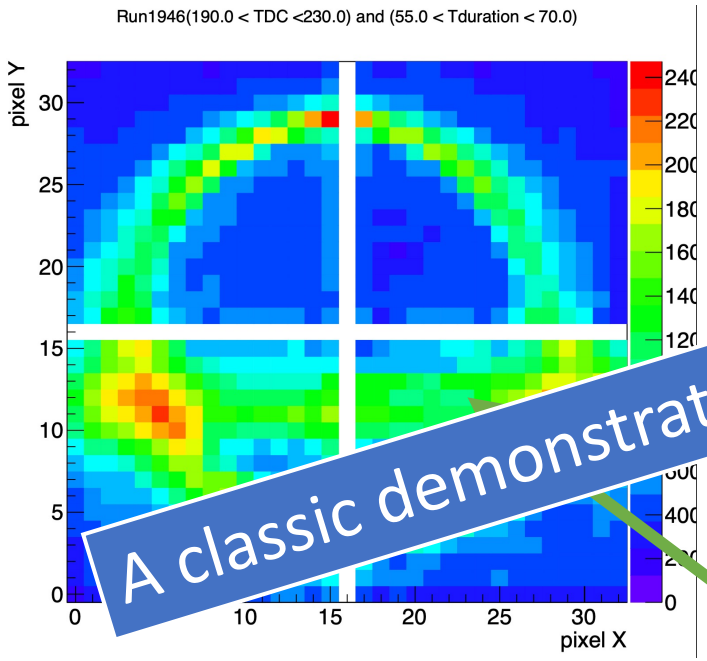
- Sharper & small ring image in comparison to proximity focusing
- Compact, projective, and modular (confining signal photons within one module)



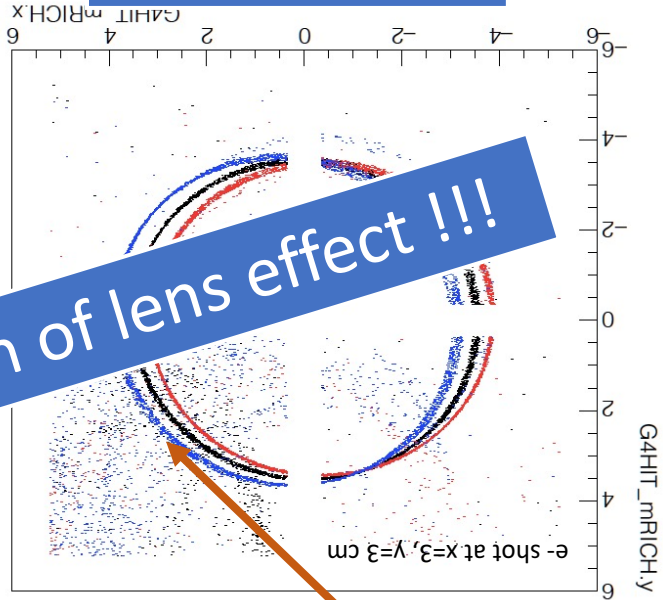


Area view of the setup





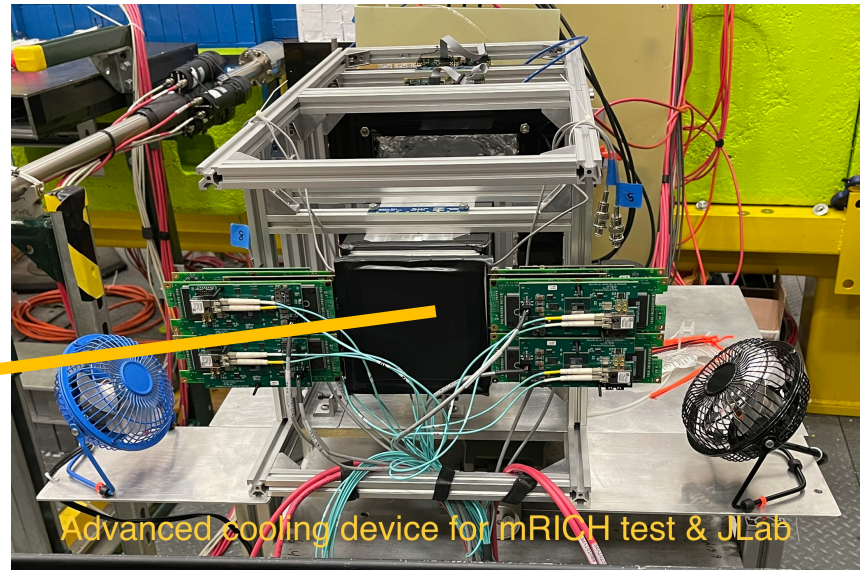
GEANT4 Simulation



A classic demonstration of lens effect !!!

Simulated electron hit

Band of electron beams



Viewed from back

Big thanks go to JLab support team in Hall D.
from eRD14 Team

Xiaochun He, 9/22/2021

eRD101 (mRICH) main objectives and the team

- Continuing mRICH performance characterization and improving its deisgn for realistic installation with maximization of acceptance.
- Mitigating the risk factors

The member institutions of mRICH team include ANL (Junqi Xie), BNL (Alexander Kieslev et. al.), Duke University (Zhiwen Zhao et. al.), Georgia State University (Xiaochun He et. al), INFN/Ferarra (Marco Contalbrigo et. al.), University of South Carolina (Yordanka Ilieva), University of Virginia (Kondo Gnanvo).

Recently recruited: Edward Kistenev, Igor Shein (IHEP) and Alexander Barnyakov from Novosibirsk (BIND) and Moscow (INR)

Proposed R&D in FY22

- JLab test data analysis
- GEANT4 simulation
- Optical components and characterization
- Engineering design
- Build new prototype with tracking capability

Table 1: List of major budget request in FY22.

Category	Qty	Cost
Postdoc at GSU	1	$60k
Postdoc at INFN	1	$40k
Engineering support	2-month	$20k
Aerogel purchase	10	$10k
Readout	8	$20k
Mirrors and Fresnel lens	4 sets	$2k
GEM tracker and readout	1	$15k
Material supplies		$3k

A synergic R&D on Aerogel and mirror with INFN group will minimize the overall cost of the project.

3 Proposed mRICH R&D Activities in FY23/24

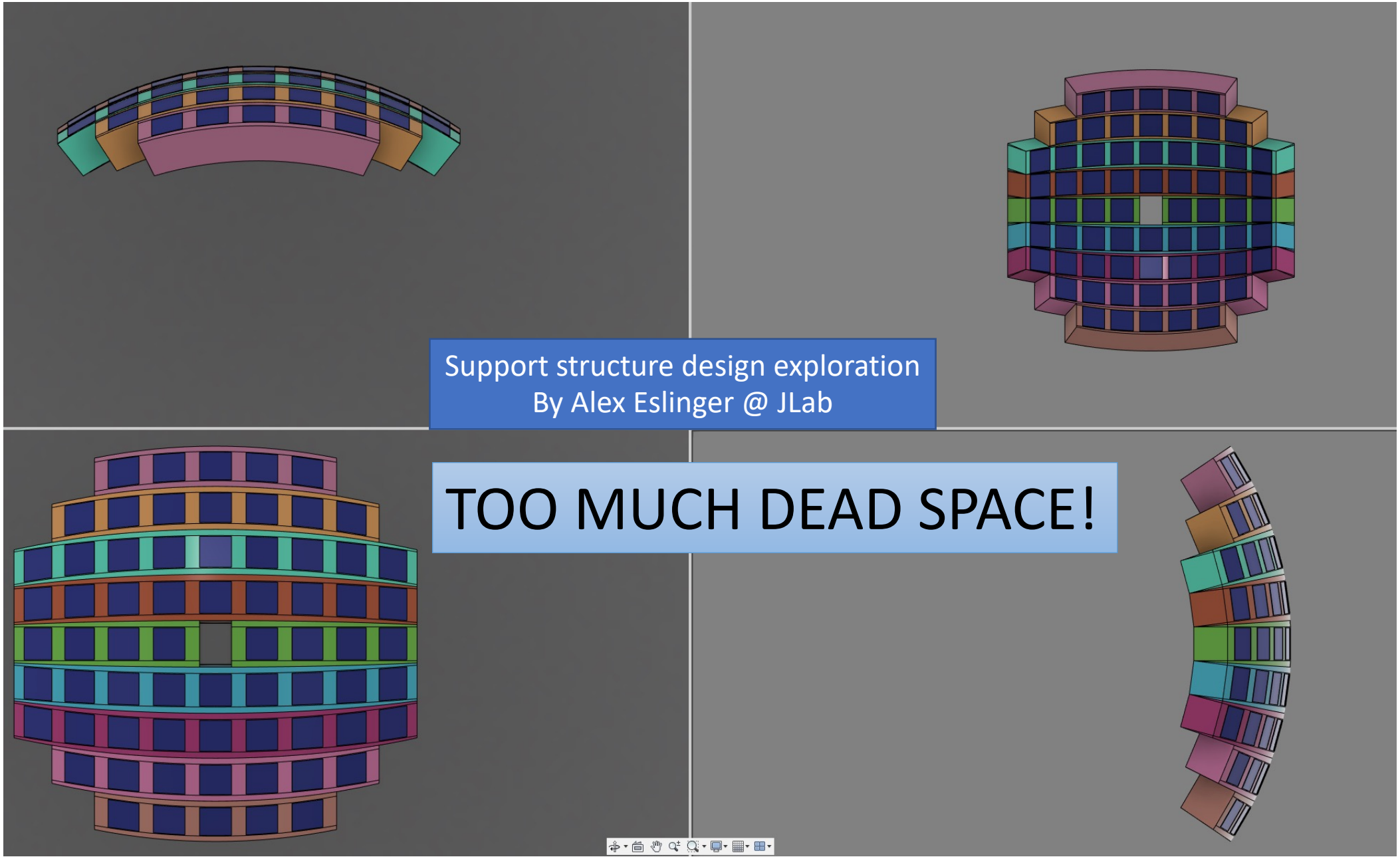
The identified R&D activities in FY23/24 will follow the success of the FY22 plans. We will be focusing on realistic beam tests with newly identified photosensors and readout. The general plan includes the following:

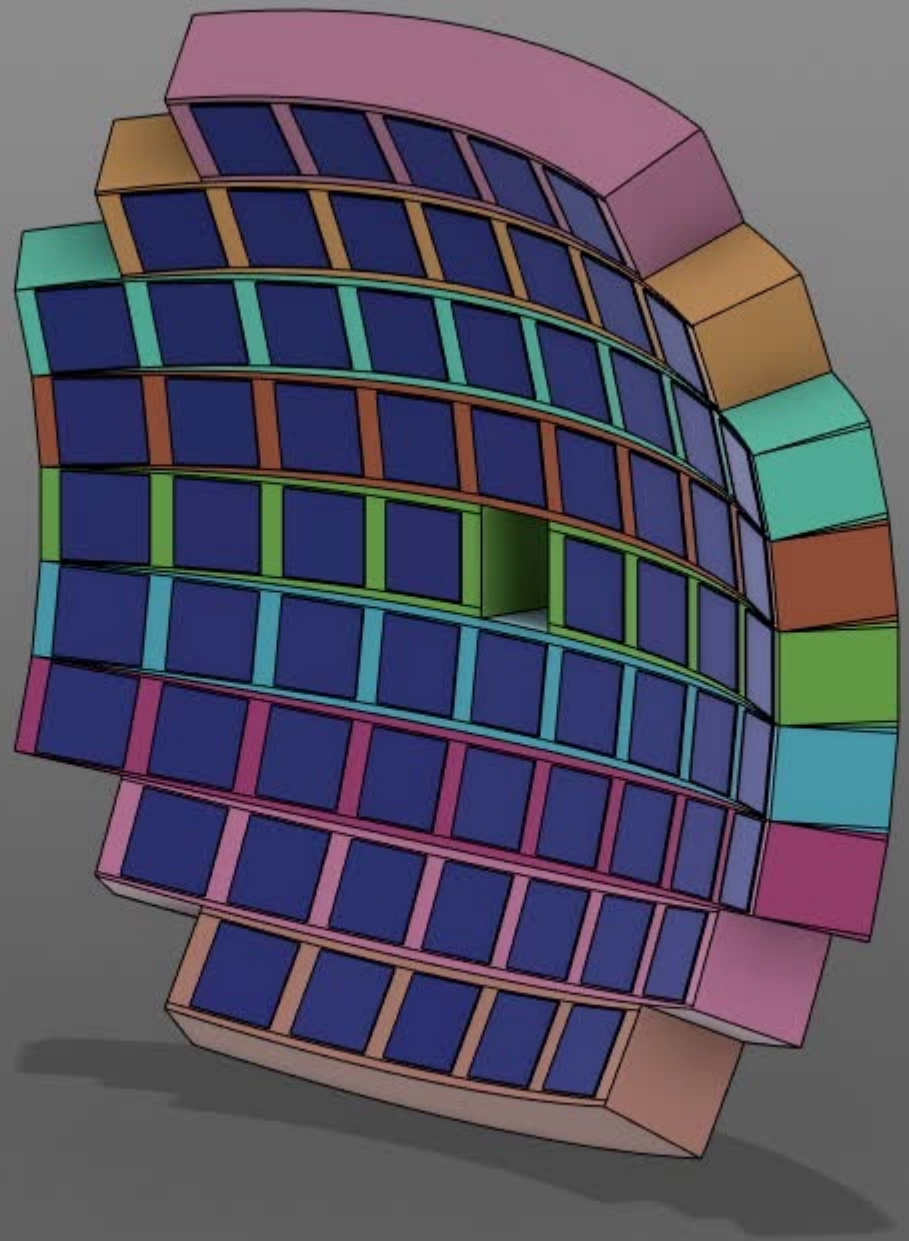
- mRICH performance tests of K/π and e/π separation in FY23 with optimized aerogel and prototype layout.
- mRICH tests with new photosensors in FY24. The expected focus will be using new generation of LAPPD (10cm $\times$ 10cm formfactor) and SiPM sensors with properly engineered cooling.

As it was done in past, the success of mRICH development will depend on team effort with synergies among the members from participating institutions and beyond. It is our intention to closely follow the development in eRD110 and to coordinate joint mRICH beam test. As an example, Kondo Gnanvo from UVA has expressed strong interest in studying LAPPD for mRICH using capacitive pad's readout.

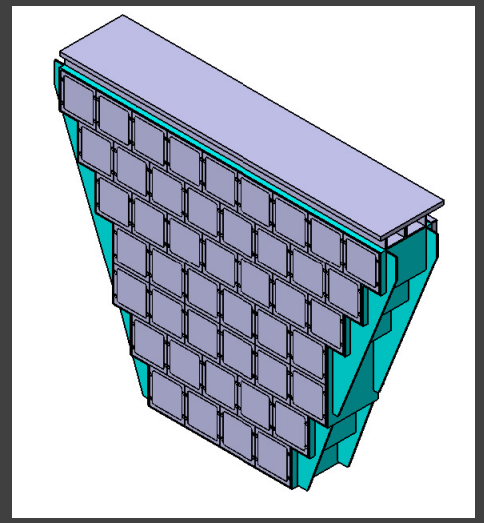
Our projected funding requests include support for purchasing photosensors, readout electronics, travel, and manpower is \$150k per year in FY23 and FY24.

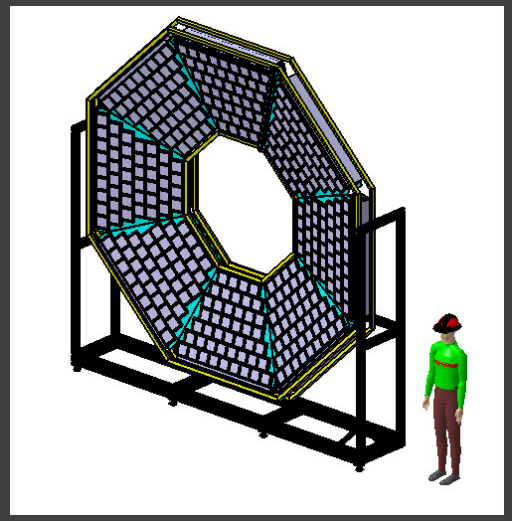
A few sample of design ideas

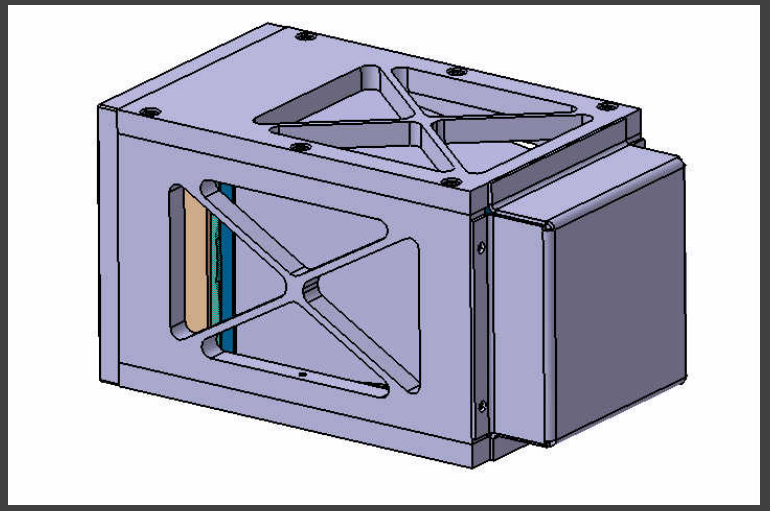

Support structure design exploration
By Alex Eslinger @ JLab
TOO MUCH DEAD SPACE!

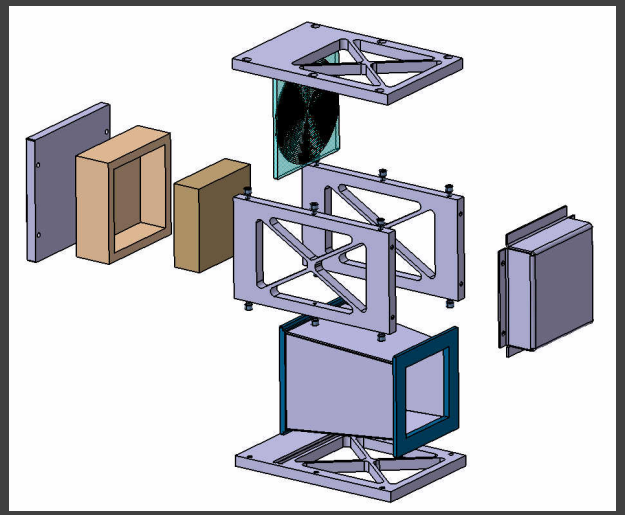


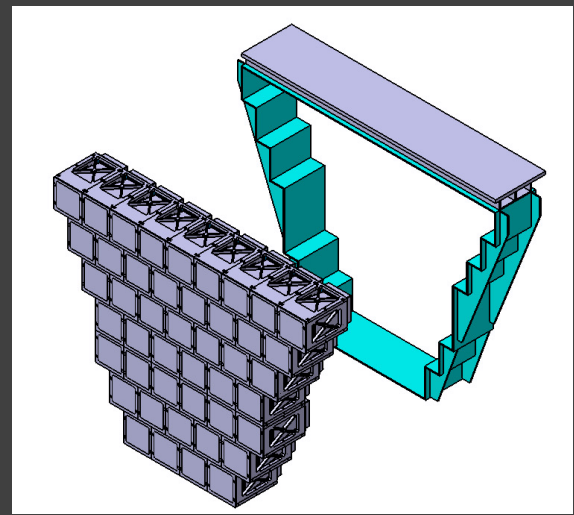
Quick design demonstration by IHEP team
(Igor Shein & his team) in less than three weeks



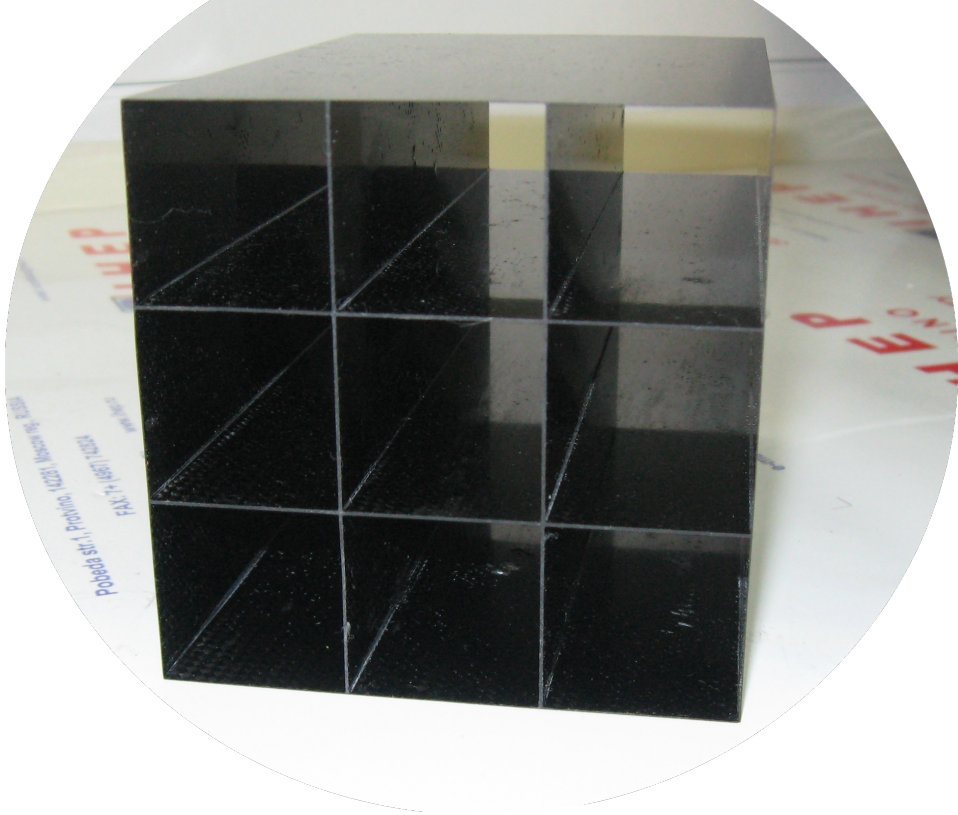








Note: This is NOT the version of mRICH array implemented neither in ATHENA nor in ECCE.



Received at GSU in August 2021 as a sample of carbon fiber cell.